

Automated Metros enable future public transport

November 2016



Transports
Metropolitans
de Barcelona

Ramon Malla

Director of Automated Lines
TMB. Barcelona



1

TMB Introduction

2

Automated Lines. L9&L10

3

TMB: Why automation?

4

TMB Automation : window of opportunity

5

Automation in the world

TMB introduction



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Barcelona, 1924

Inauguration 1st metro Line



TMB introduction



Barcelona, 2016

25% km metro network
fully automated



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Automation in the world

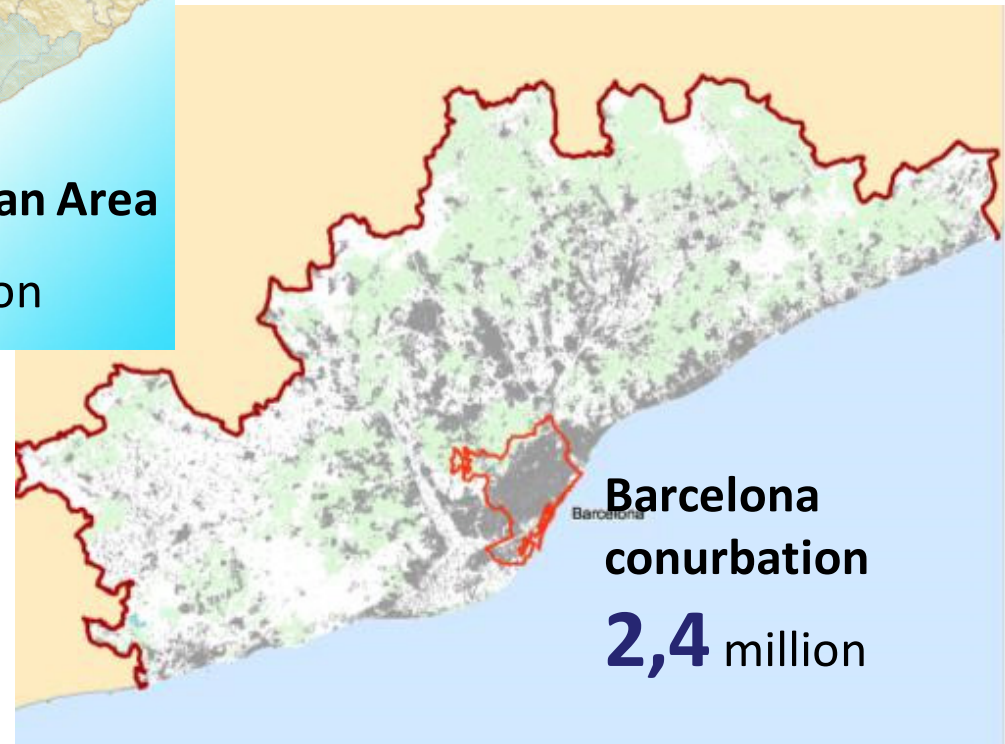
TMB introduction. City and Metropolitan Region



Catalonia



**Barcelona
Metropolitan Area
3,2 million**



**Barcelona
conurbation
2,4 million**

TMB introduction. Metro network



Transports Metropolitans de Barcelona (TMB)

The main public transport operator in Barcelona. Multi modal (Metro, Buses)

Metro since 1924

1,3 million/day

122 km

156 stations



Sunday to Thursday



Fridays and Bank Holidays



Saturdays and some Bank Holiday's

- 1 TMB Introduction
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Automated Lines. L9&L10

📍 Backbone of city's public transport


- 48 km
- 52 stations

📍 Connects city strategic sites

- Airport
- Port Logistic Area
- Main Court of Justice
- High Speed Rail
- University Campus
- Trade Fair
- Hospitals
- Stadium. FC Barcelona




Automated Lines. L9&L10

 **2009-10. 3 phases**

✓ 11 km



✓ 12 Stations

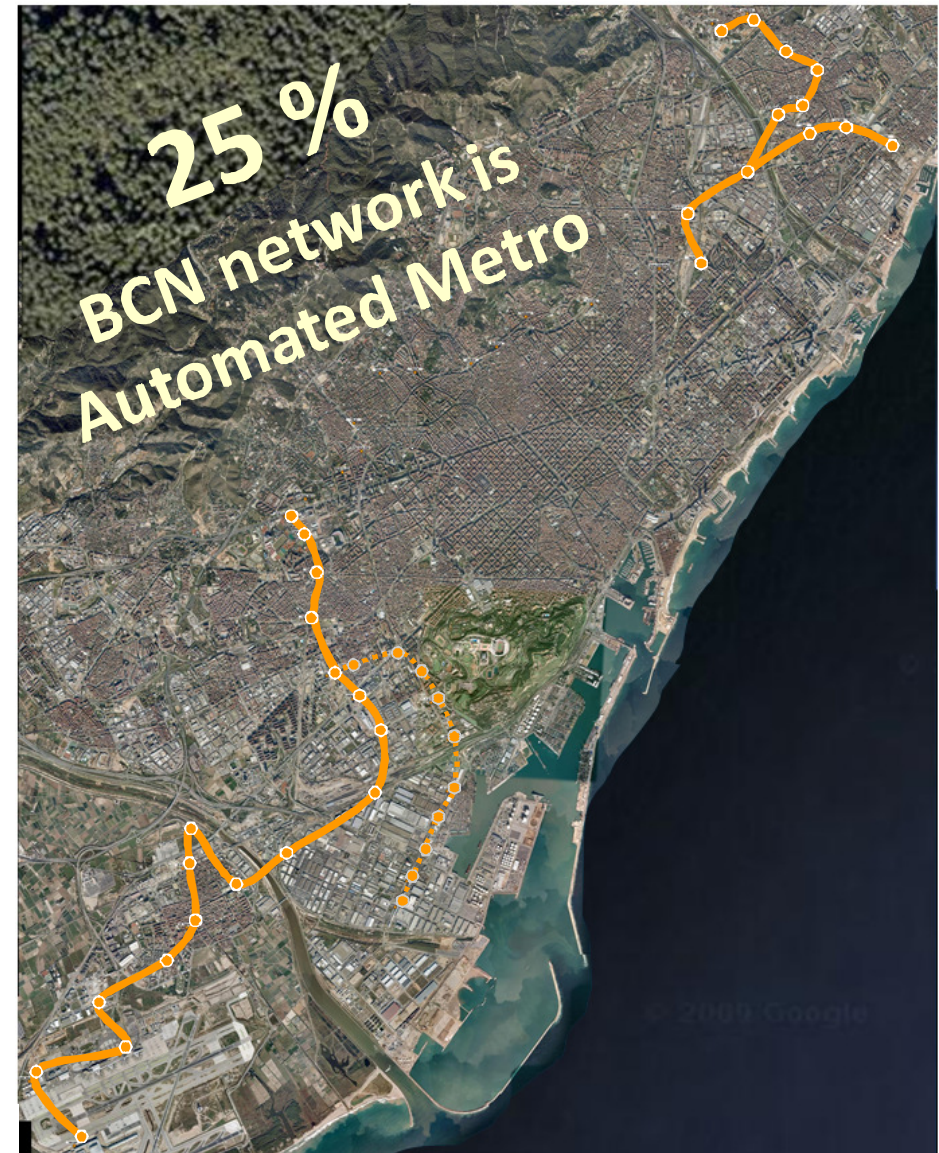
 **2016. 1 phase**

✓ 19,6 km



✓ 15 stations

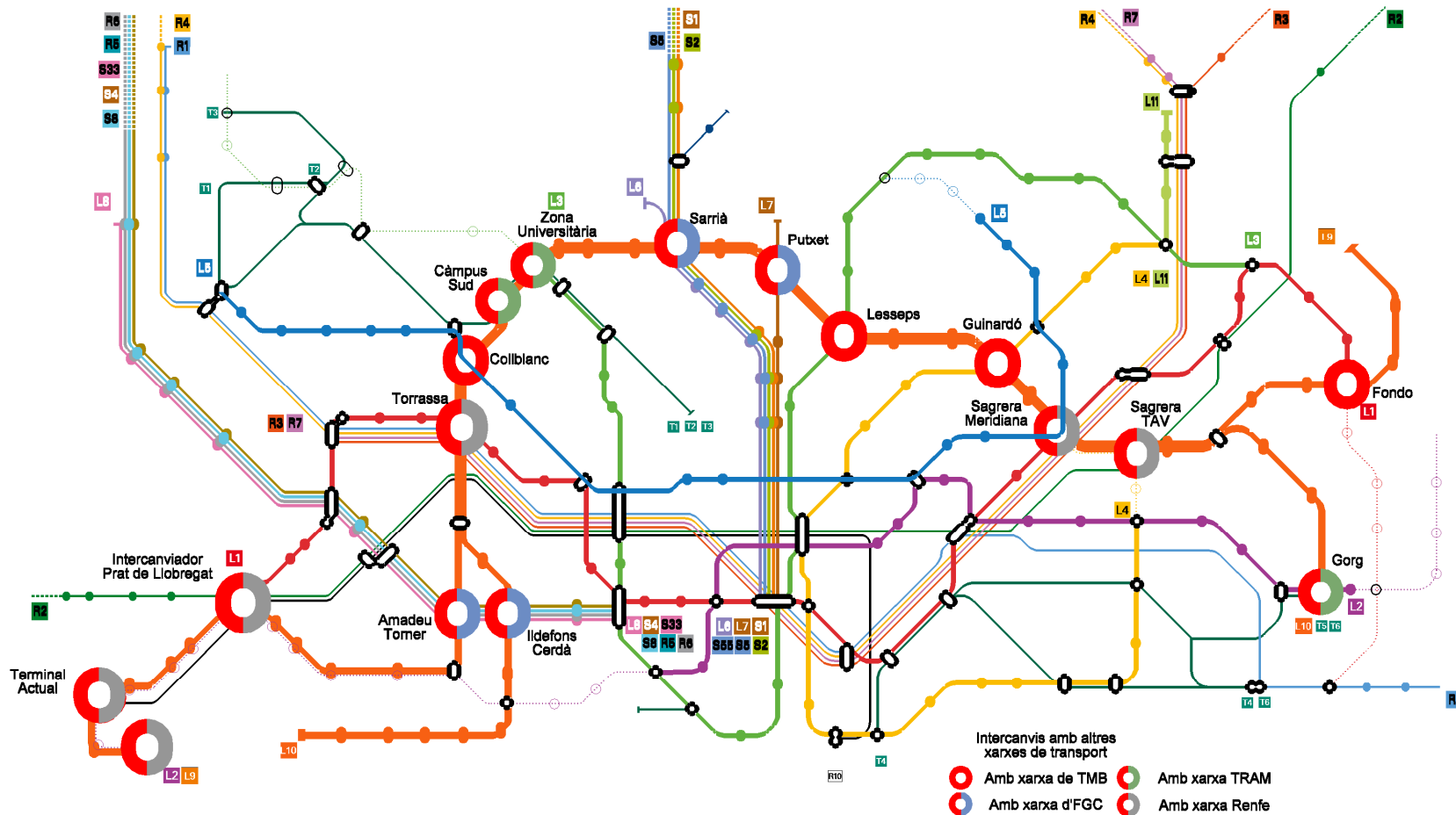
✓ + 5,9 km workshop connection



Automated Lines. L9&L10. Metro Network



- Key role for metro network : Connections with all the lines
- 52 stations 48 km



Automated Lines. L9&L10. Infrastructure

Traditional
construction
approach
no feasible



Automated Lines. L9&L10. Infrastructure



**New
construction
model**



Automated Lines. L9&L10. Infrastructure

Innovative
construction model
“shaft stations”

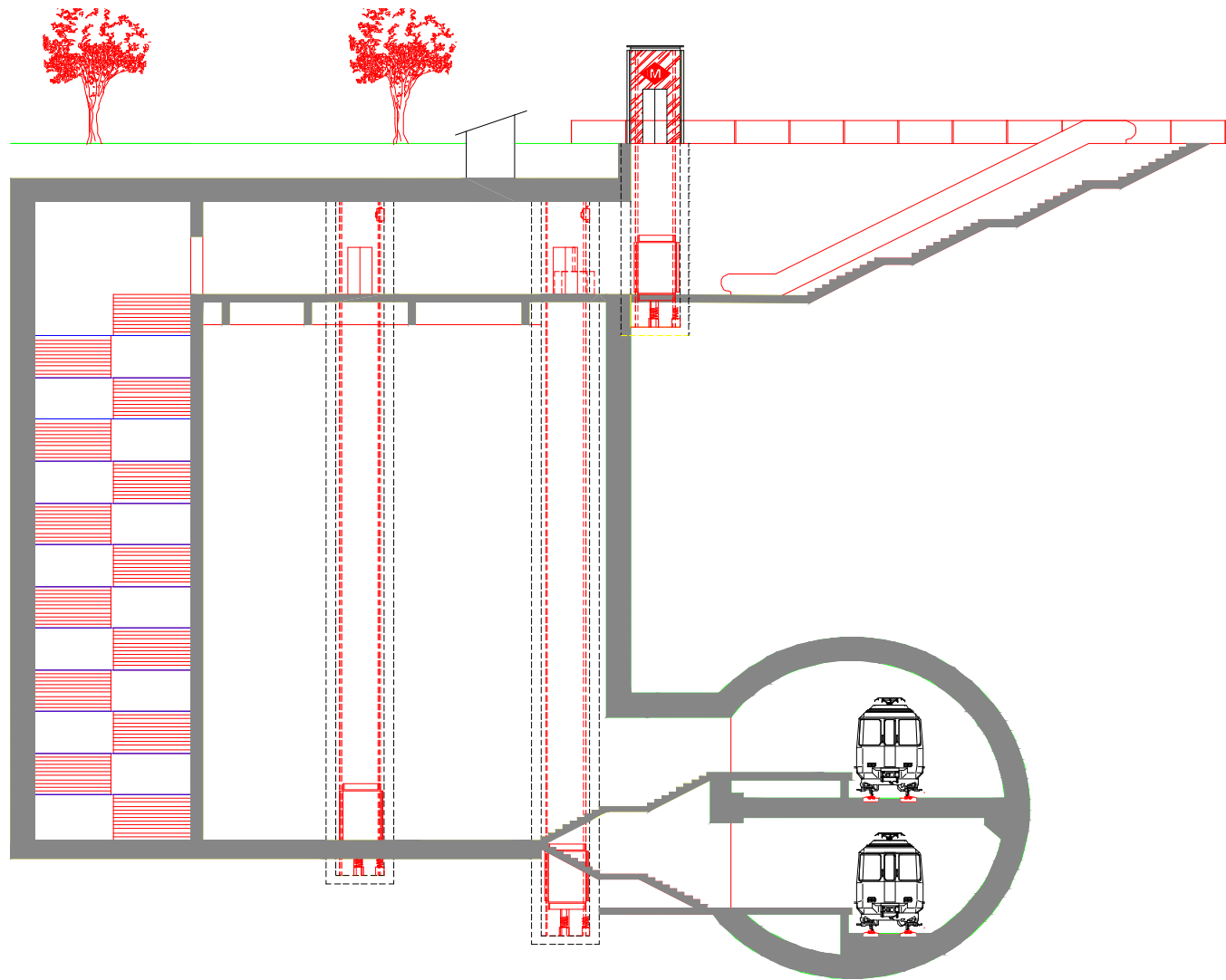
L9 stations are easy to
adapt within a densely
urbanized area



Automated Lines. L9&L10. Infrastructure



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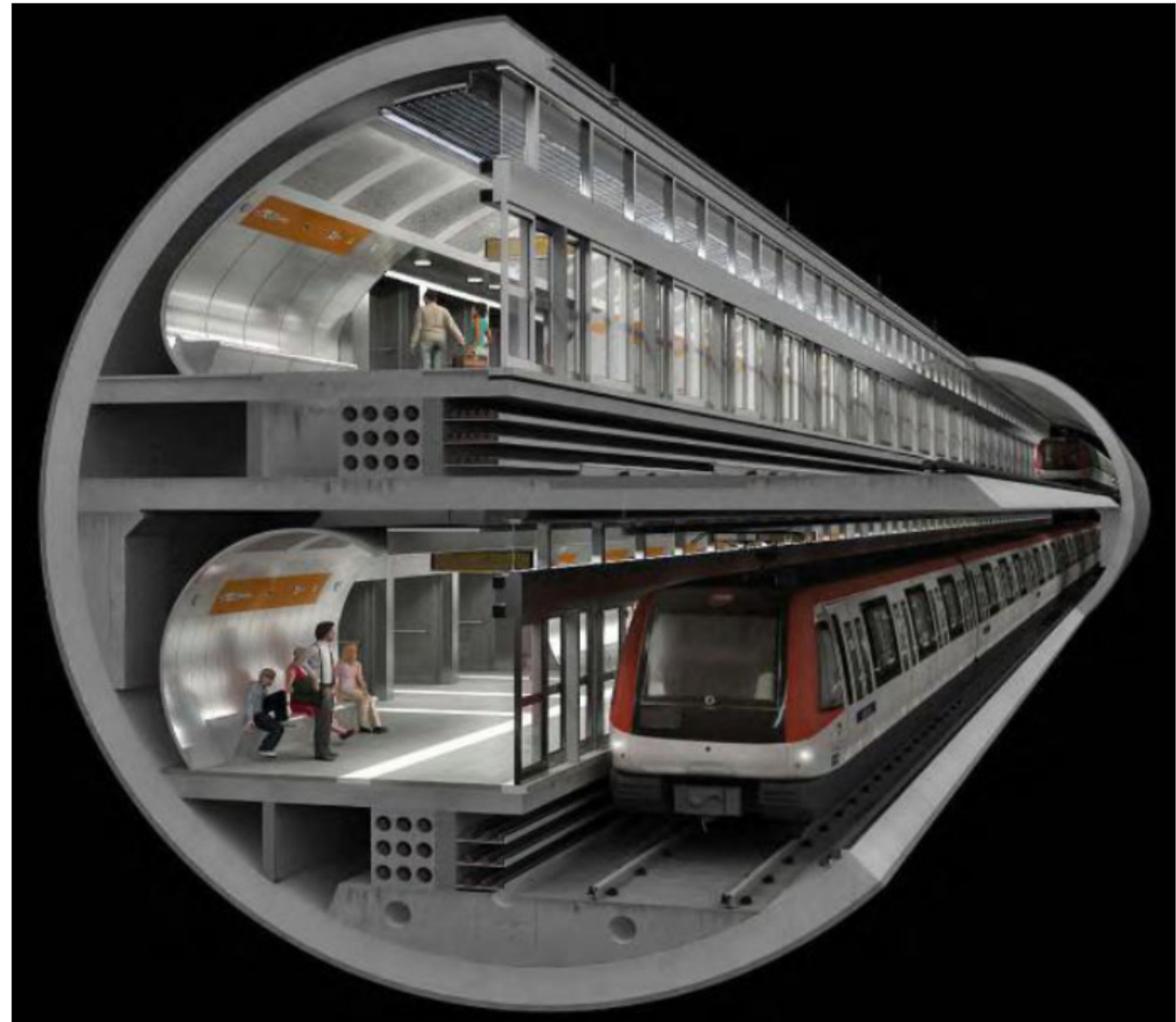


Automated Lines. L9&L10. Infrastructure



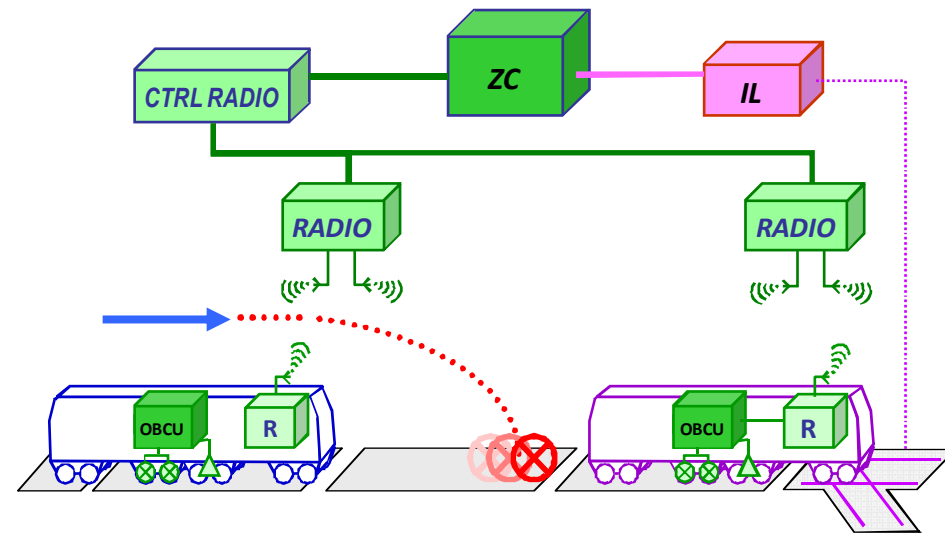
Automated Lines. L9&L10. Infrastructure

- **Two-level tunnel (12 m)**
- **Platforms within the tunnel**
- **Space available for equipment.**
- **The semi-tunnels are safety area**



Automated Lines. Technology. Driverless

- **Fully automated** : No staff on board required
- Grade of Automation : **GoA4**



- **Fully automated train movement**
 - **CBTC system** : Communications-Based Train Control
 - Critical equipment **redundant**
 - Precise trains **location**
 - Continually **data exchange** : speed, destination, track switching, distance between trains, station stop, doors closing ...

Automated Lines. Technology. Driverless



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- 3 TMB: Why automation?**
- 4 TMB Automation : window of opportunity
- 5 Automation in the world

TMB: Why automation?

Mobility

**Human
side**

**Capacity
Increase**

**Operational
Flexibility**

**Improved
Customer
service**

**Higher
Safety**

**Cost
efficiency**

Mobility

- Transport **capacity**
 - **Peak hour**
 - **Off peak hour** : good service
- Operation **flexibility** : Adjust **supply and demand**
- Response for **singular scenarios**
 - city events (sport, demonstrations ...)
 - night service ...
- **Reliability** : less service interruptions

Better service !



Higher safety

- 🚫 Metro : **Safety first !!**
- 🚫 Technology takes on functions that will guarantee **greater safety** by eliminating **human error**
- 🚫 **Platform safety** for passengers
- 🚫 Driverless : Impressive **safety records**



first reason for automation !

Cost efficiency

- **Energy savings**
- Adjusting **supply to demand**
- Optimization **trains fleet** size.
 - commercial speed
 - dwell-time in stations ...
- **Labor cost**



Impact on labor cost depends on the
organization approach

Human side

📌 Opportunity: To meet the new expectations of employees

- 📌 The academic training expanding
- 📌 “Drivers “ ?
- 📌 “Locked” inside a cabin



A more “sustainable “organization :
from “routine jobs” to “fulfilling jobs”

📌 Automated line :

- 📌 An automated line requires new **functions** and new **job profiles**
- 📌 **Staff closer to the customer**



a more humane approach for employees and customers

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Window of Opportunity



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2016
Decision

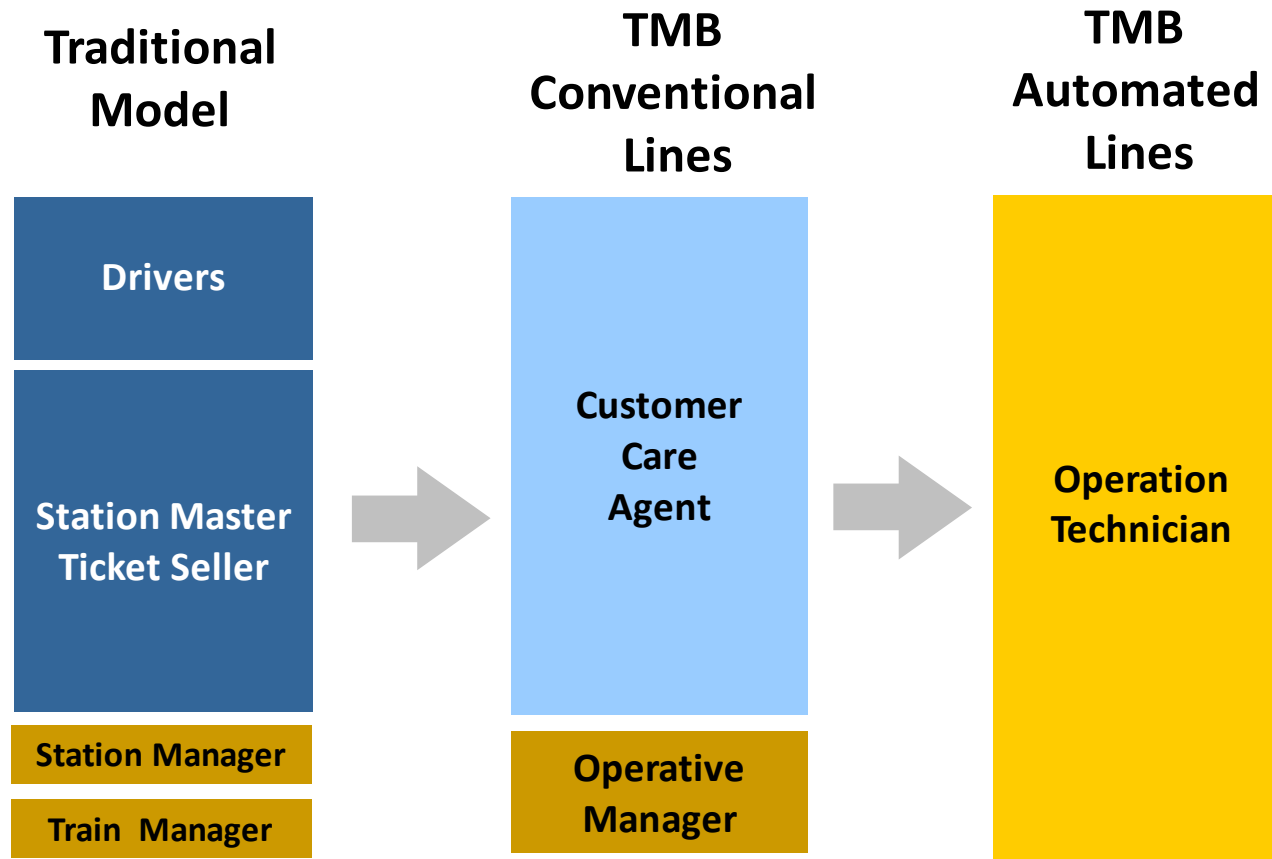
2020

+30 years

Window of Opportunity. "Organization"



TMB operational evolution towards driverless



Window of Opportunity. “Automation scope”



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End-to-end “Extended” Automation Concept

Circulation



Stations



Window of Opportunity. “Conversion to driverless”



TMB bid for automation: 2009 Line 11 first line “converted” GoA3

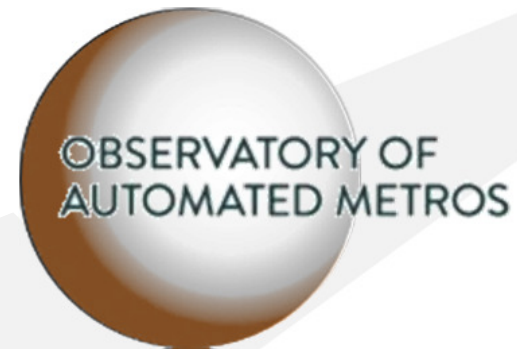
L11

1st platform
screens doors
in Barcelona



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- 4 TMB: Results
- 5 Automation in the world**

UITP & Observatory of Automated Metros



UITP response to tackle METRO
AUTOMATION challenges

Automation in the world



Observatory Members: Integral Automation Experience



Barcelona



Copenhaguen



Dubai



Hong Kong



Lausanne



Lille, Rennes, Lyon



Milano



Nürnberg



Paris



Roma



São Paulo



Singapore

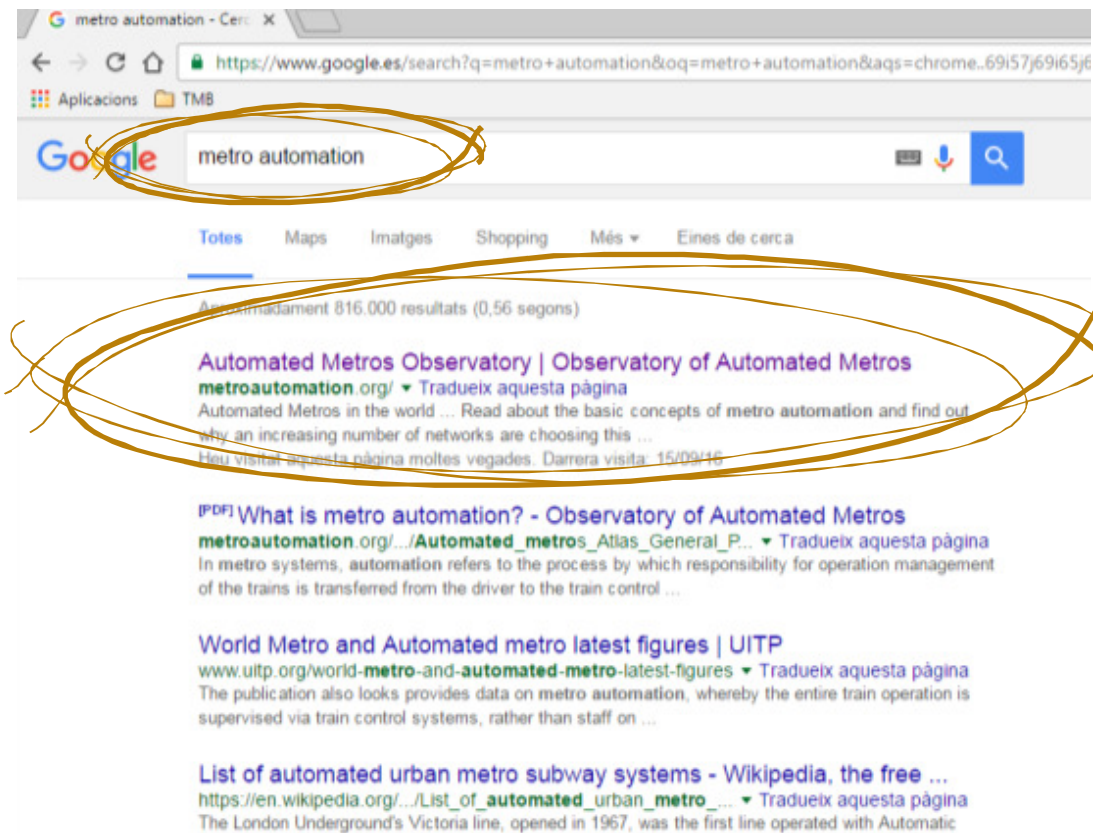


Vancouver

Automation in the world



Observatory Website: **WWW.metroautomation.org**



1st Google entrance when search for **metro automation**

Selection **criteria** applied in the study:

📌 **Fully Automated Metro:** Only metro lines designed to operate without staff on board.
GoA4.



📌 **Public transport service:** Metro lines without connection to public transport services have been discarded

📌 **Minimum train capacity required:** More than 100 passengers/train.



Automation in the world. Automation today



850

km

56

lines

Fully

Automated
today

890

st.

38

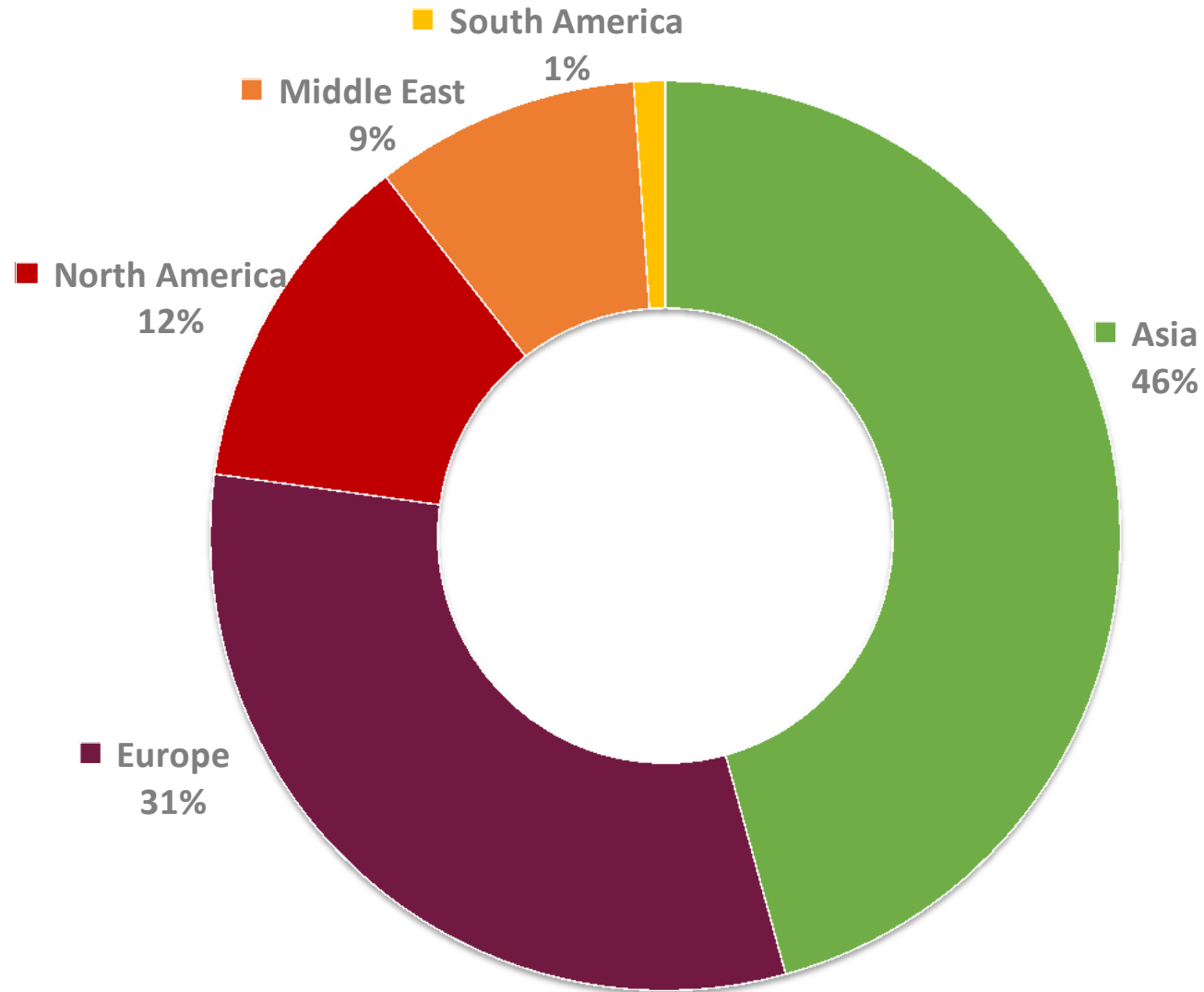
cities

Automation in the world. Automation today



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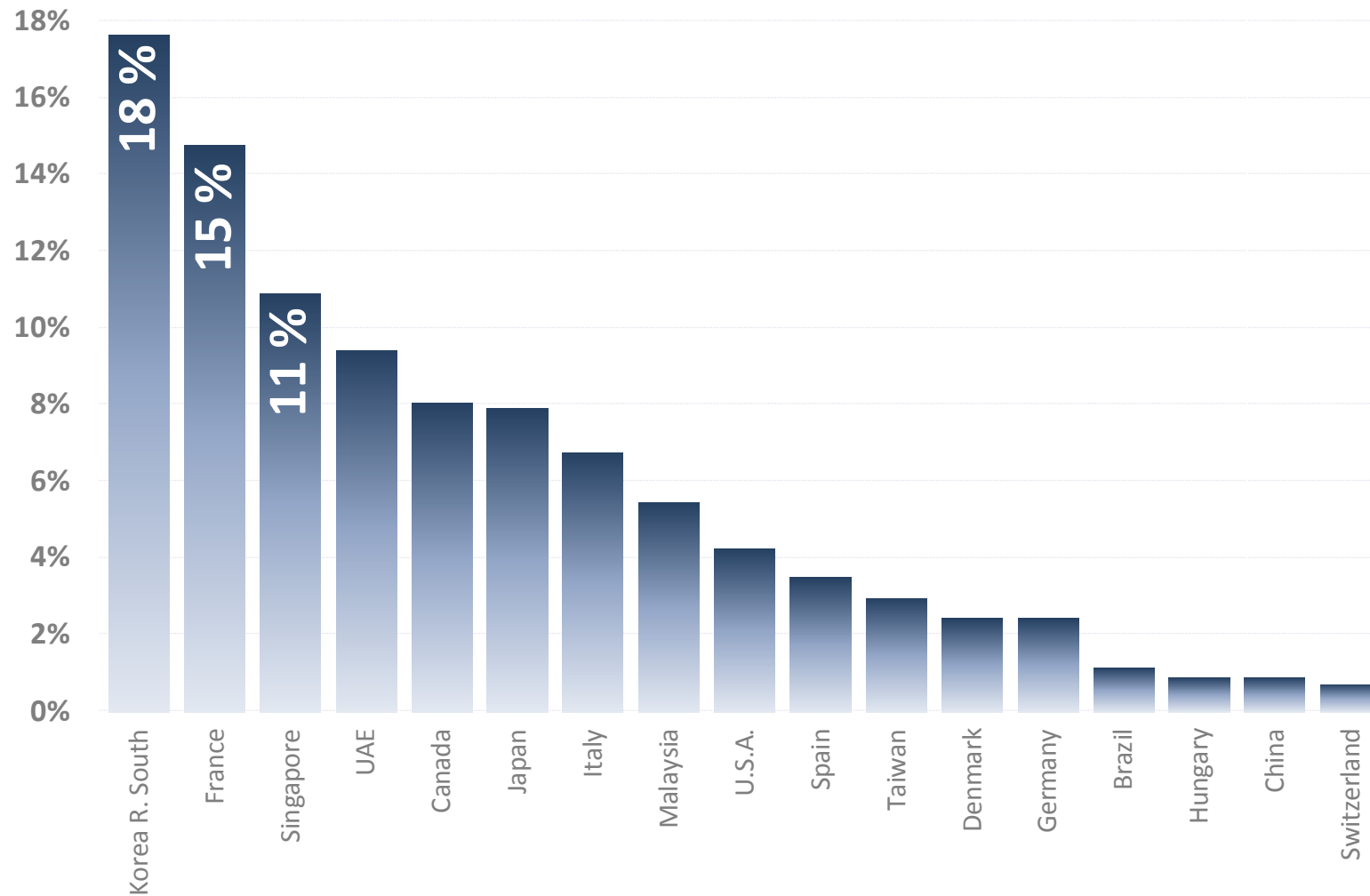
Fully automated % of total km per WORLD REGION



Automation in the world



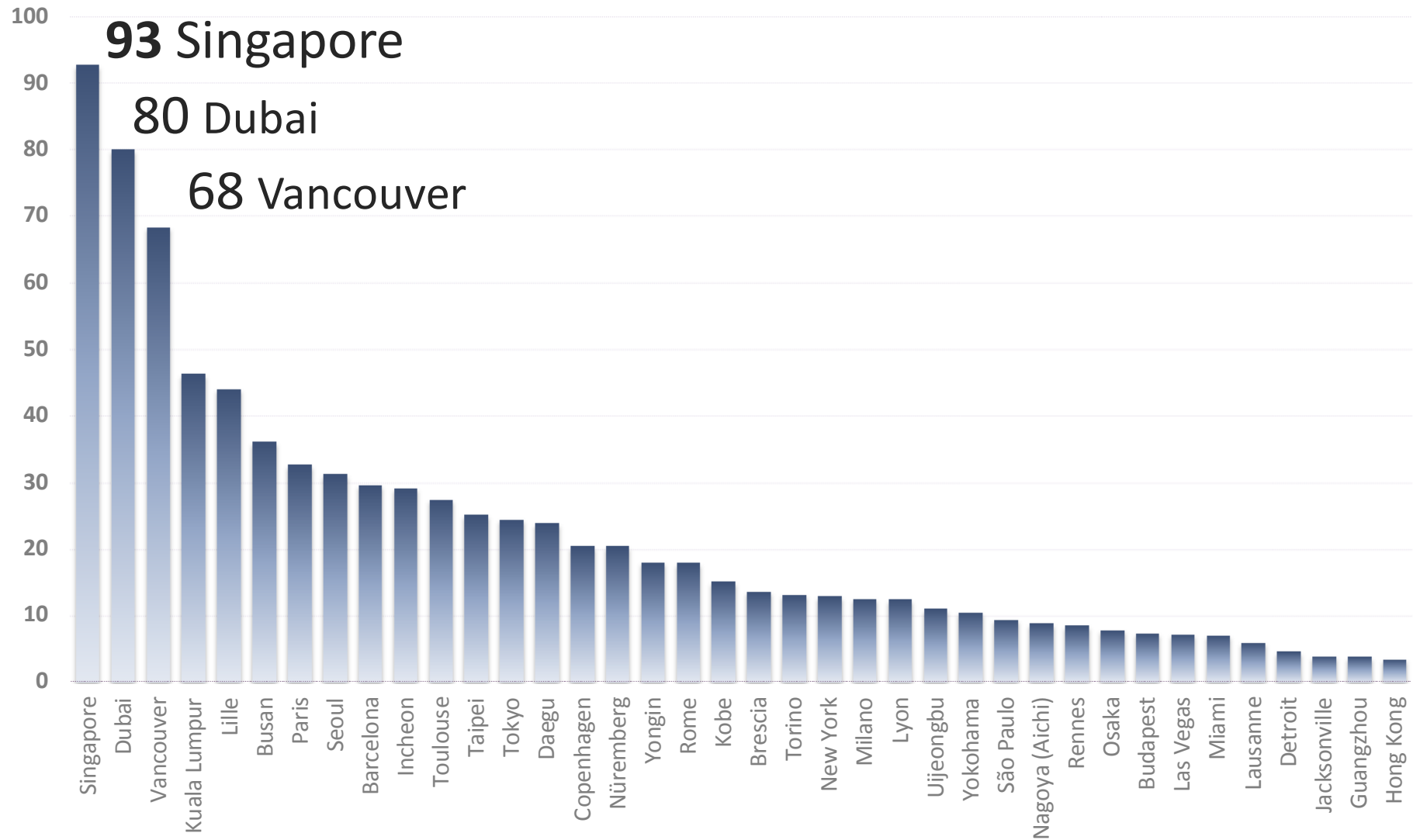
Fully automated % of total km per COUNTRY



Automation in the world



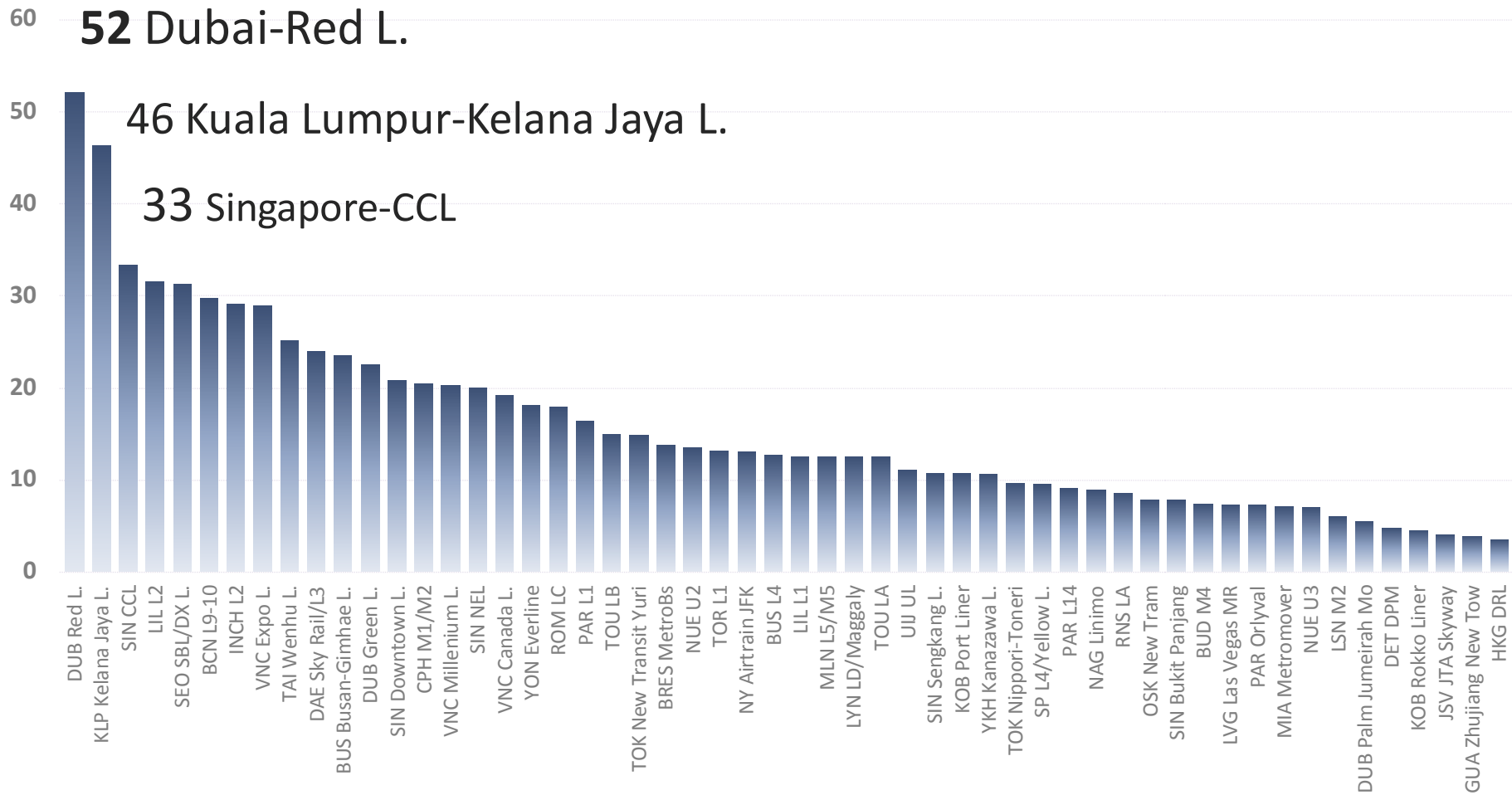
Fully automated total km per CITY



Automation in the world



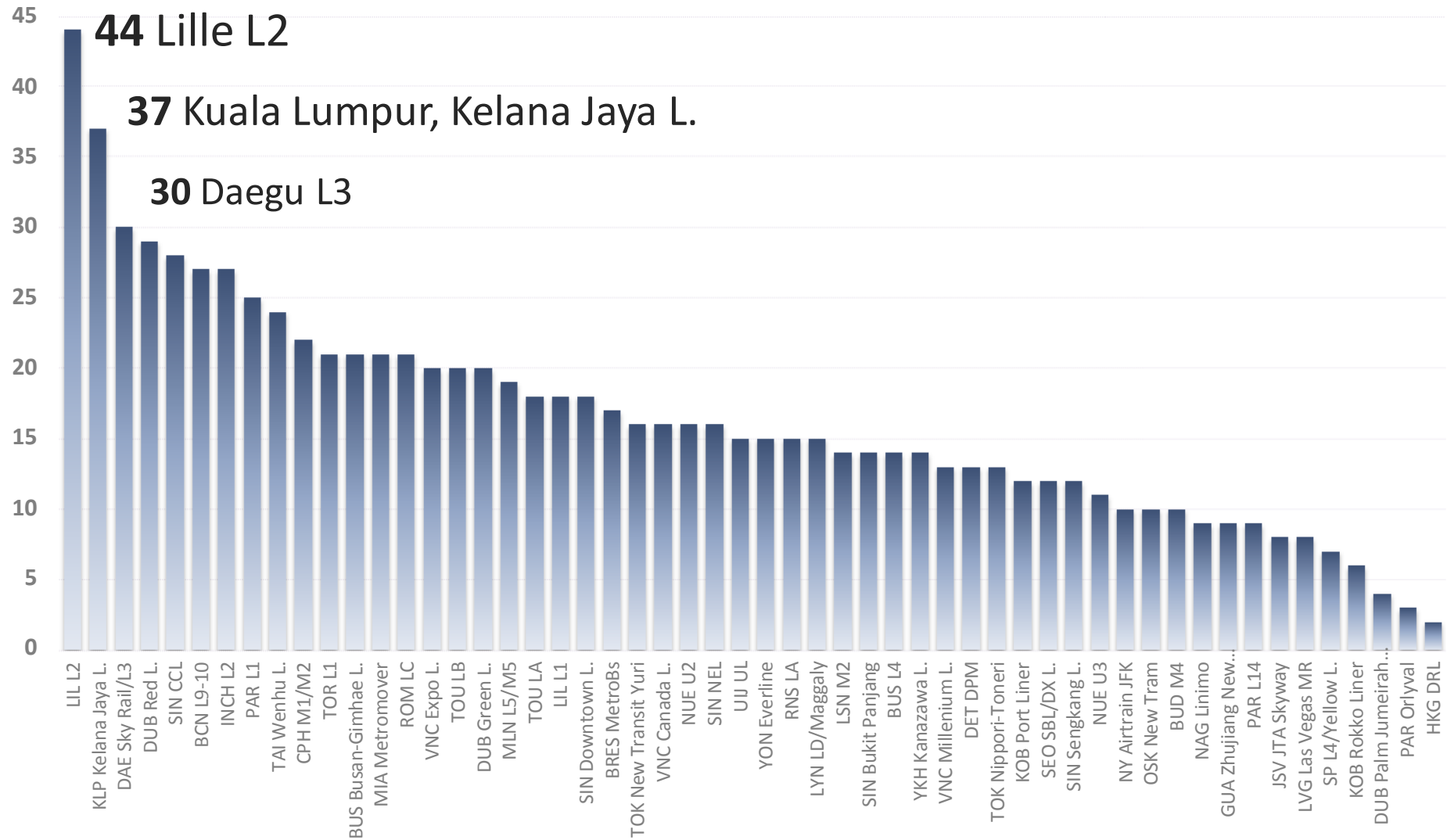
Fully automated LINES length (in km)



Automation in the world



Stations per line



Automation in the world. Train Capacity.

Train Capacity: passengers per train (as a % of km)



>700

23% - 12 Lines



300-700

49% - 25 Lines



<300

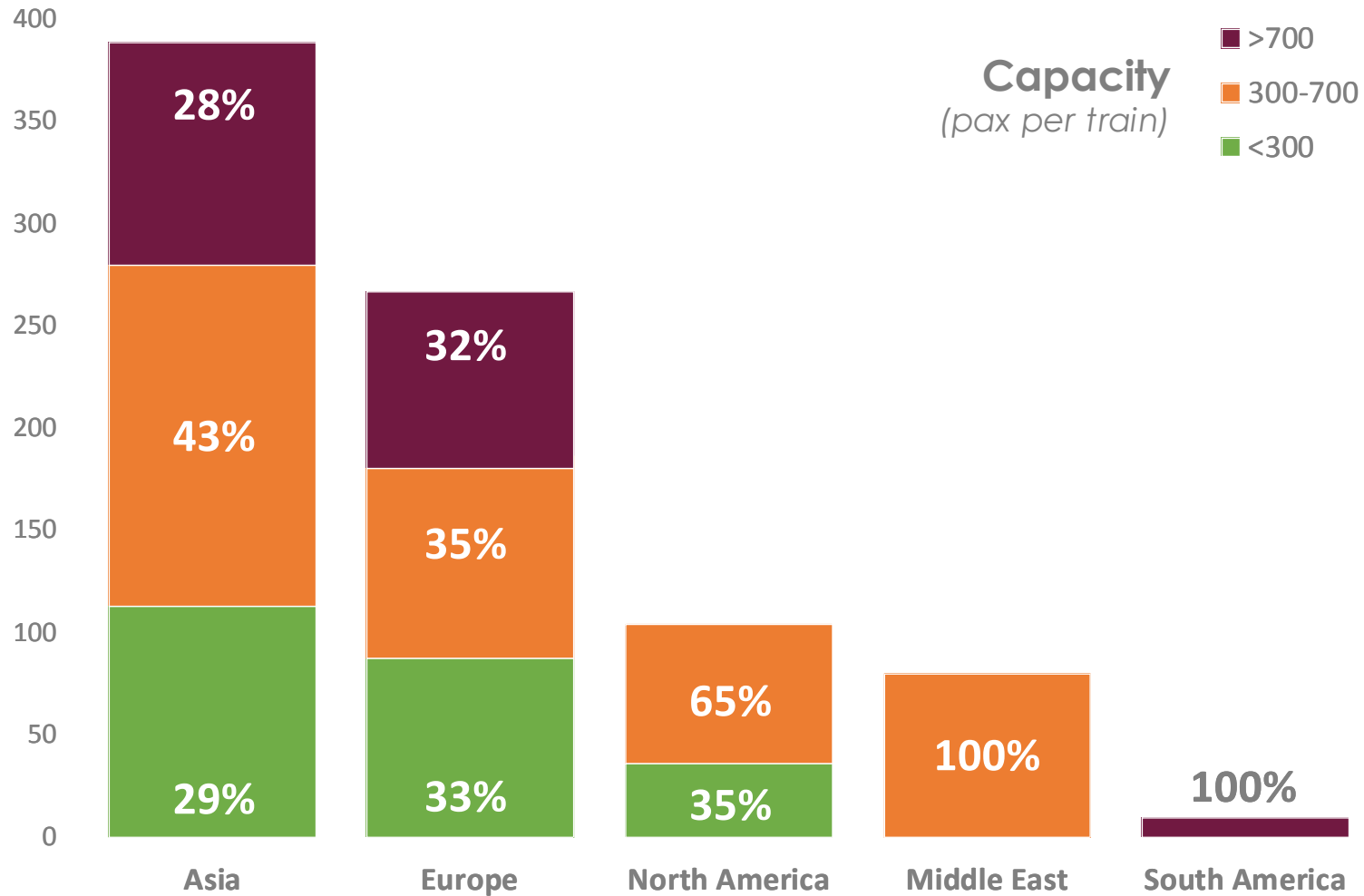
28% - 19 Lines

Automation in the world



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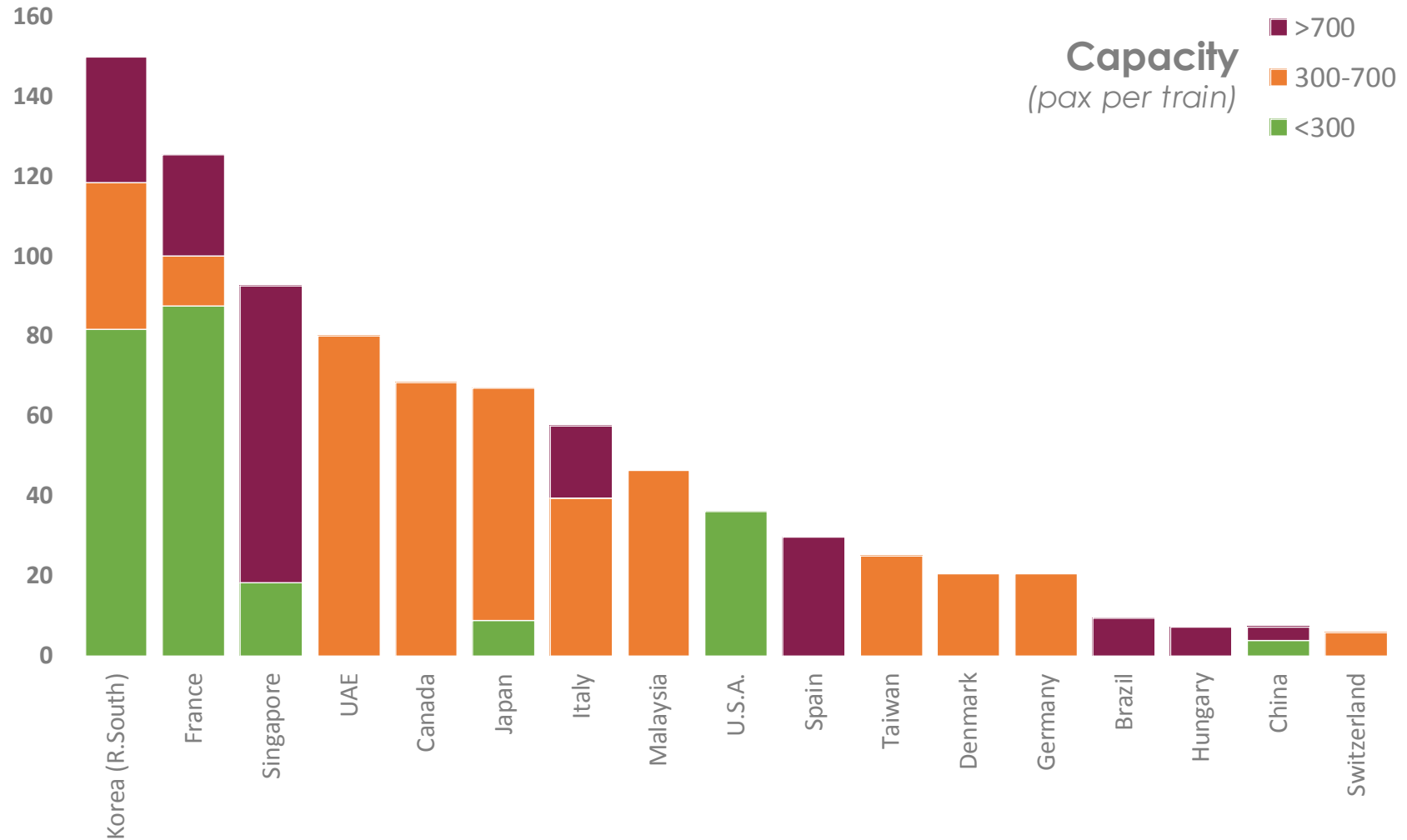
Fully automated % of km per World Region per train capacity



Automation in the world



Fully automated % of km per Country per train capacity

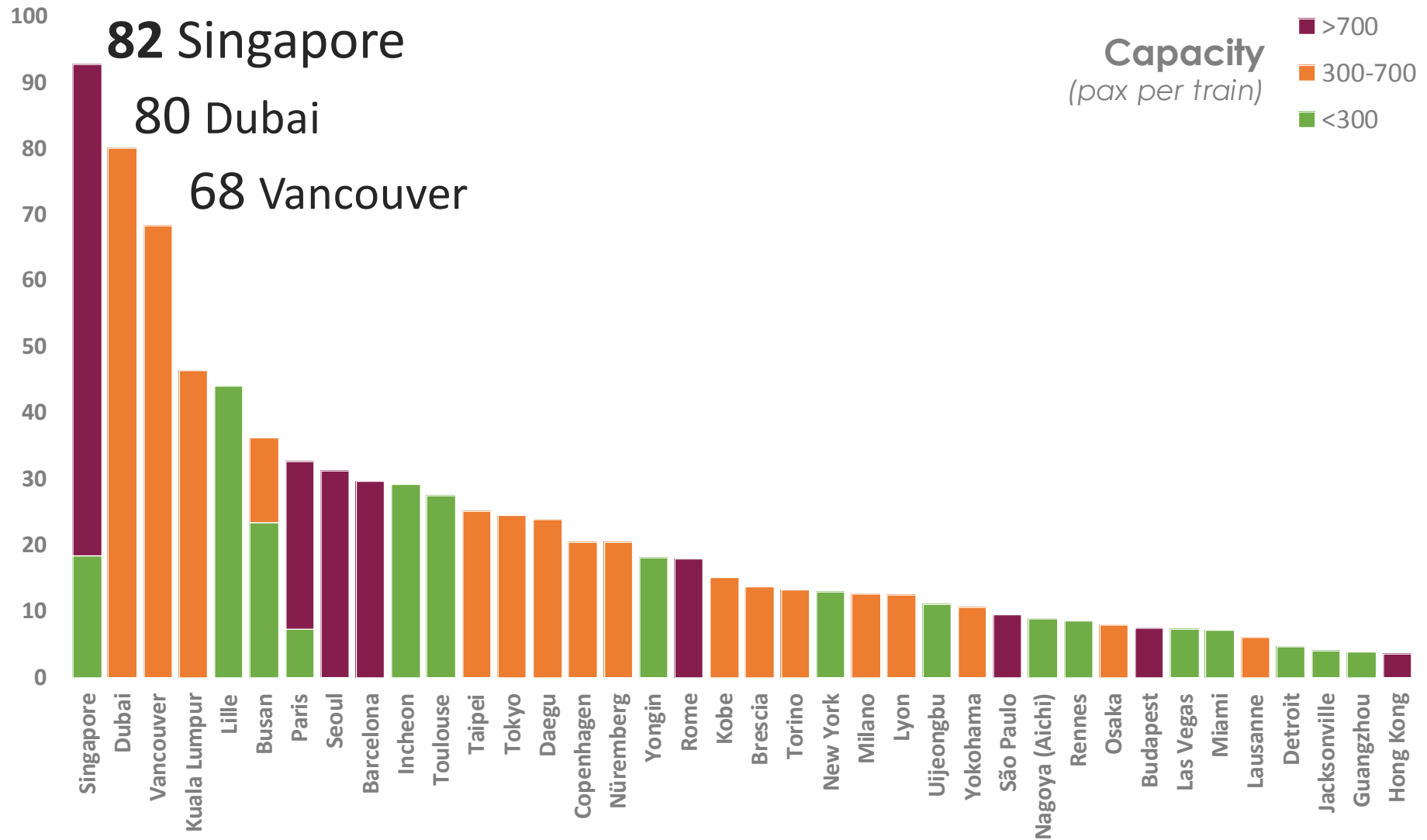


Automation in the world



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Fully automated km per City per train capacity





23 % Cities

with metro networks have
(at least one) **one fully automated line**

6 % GoA4

related to all metro lines (km)

Automation in the world



25 Biggest Metro Systems in the World

Metro network	Country	Region	km	% UTO
<i>Shanghai</i>	China	Asia	588	-
<i>Beijing</i>	China	Asia	554	-
Seoul	Korea	Asia	440	7%
<i>London</i>	United Kingdom	Europe	436	-
<i>New York</i>	USA	North America	394	-
Tokyo	Japan	Asia	381	7%
<i>Moscow</i>	Russian Federation	Asia	333	-
<i>Madrid</i>	Spain	Europe	295	-
<i>Guangzhou</i>	China	Asia	241	-
<i>Mexico City</i>	Mexico	Latin America	226	-
Paris	France	Europe	205	16%
<i>Chongqing</i>	China	Asia	202	-
<i>New Delhi</i>	India	Asia	195	-
Hong Kong	China	Asia	178	2%
<i>Shenzhen</i>	China	Asia	177	-
<i>San Francisco</i>	USA	North America	175	-
Singapore	Singapore	Asia	171	48%
<i>Washington</i>	USA	North America	171	-
<i>Chicago</i>	USA	North America	166	-
<i>Osaka</i>	Japan	Asia	166	-
<i>Berlin</i>	Germany	Europe	146	-
<i>Nanjing</i>	China	Asia	142	-
Barcelona	Spain	Europe	141	21%
<i>Tianjin</i>	China	Asia	137	-
Taipei	Taiwan	Asia	133	19%

Automation in the world

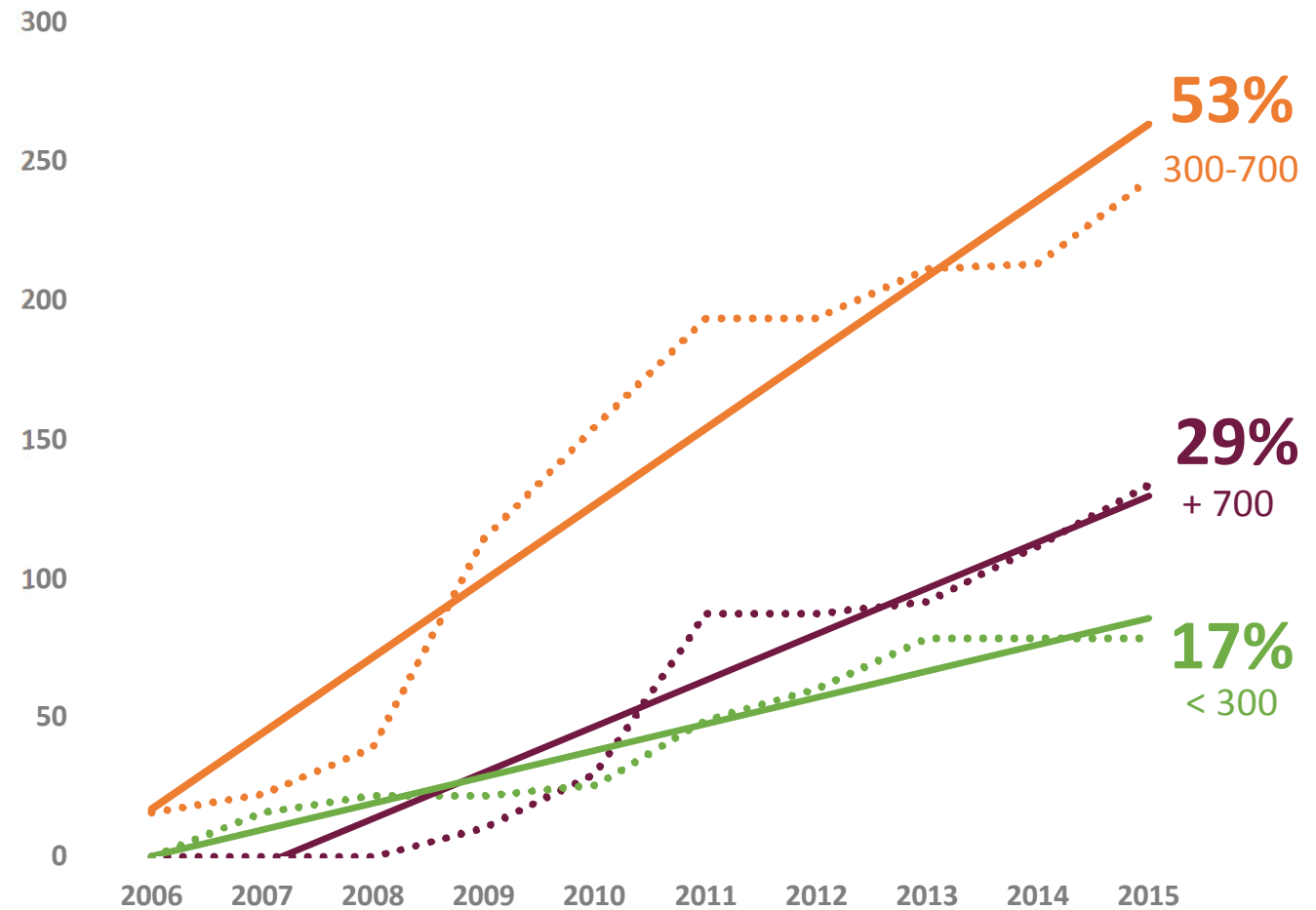
Cities with fully automated metro lines in operation



- High capacity lines: more than 700 passengers per train
- Medium capacity lines: 300 to 700 passengers per train
- Low capacity lines: under 300 passengers per train

Automation in the world. Trends & evolution

Train Capacity: Passengers per train (as a % of last decade new km's)



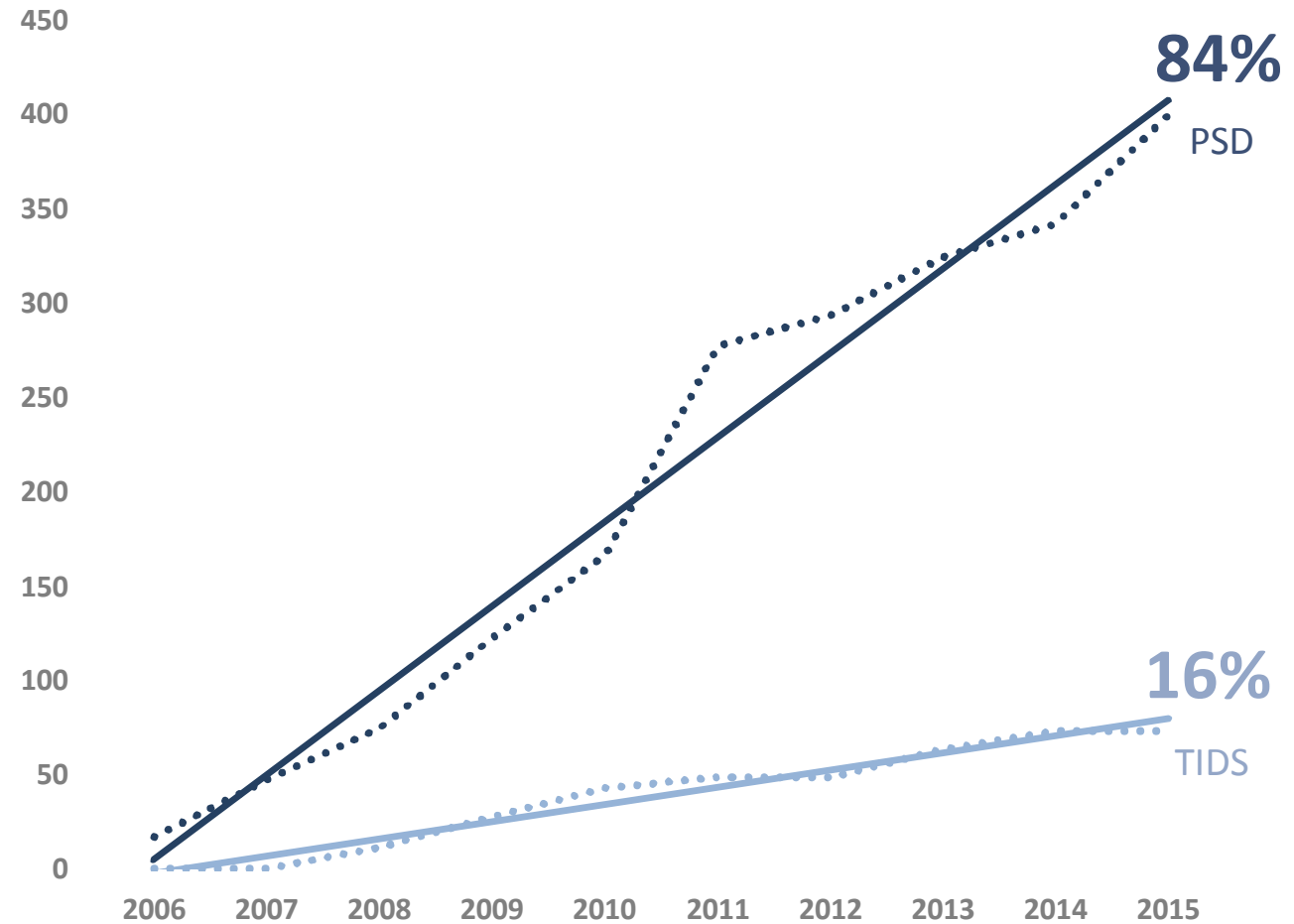
Track Protection Systems: Platform Screen Doors vs Intrusion Detection Systems (as a % of last decade new stations)



Platform Screen Doors



Intrusion Detectors



Conversion conventional lines to driverless

In operation



Nurnberg, U2
2009



Paris, L1
2012

Projects

- Paris, L4
- Marseille, L1 & L2
- Lyon, LA & LB
- Vienna, U5
- London, Docklands

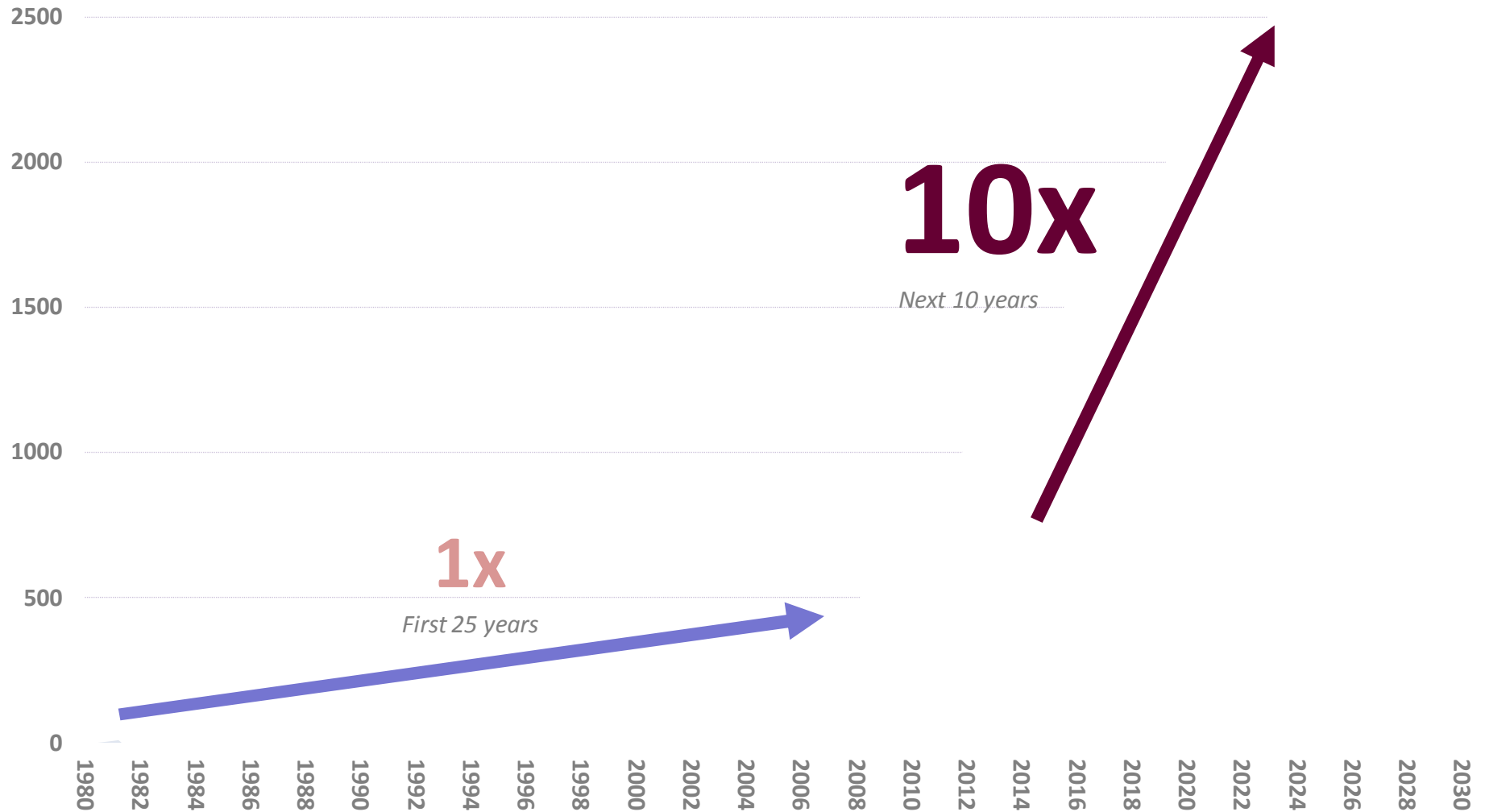
High potential

Automation in the world. Future growth



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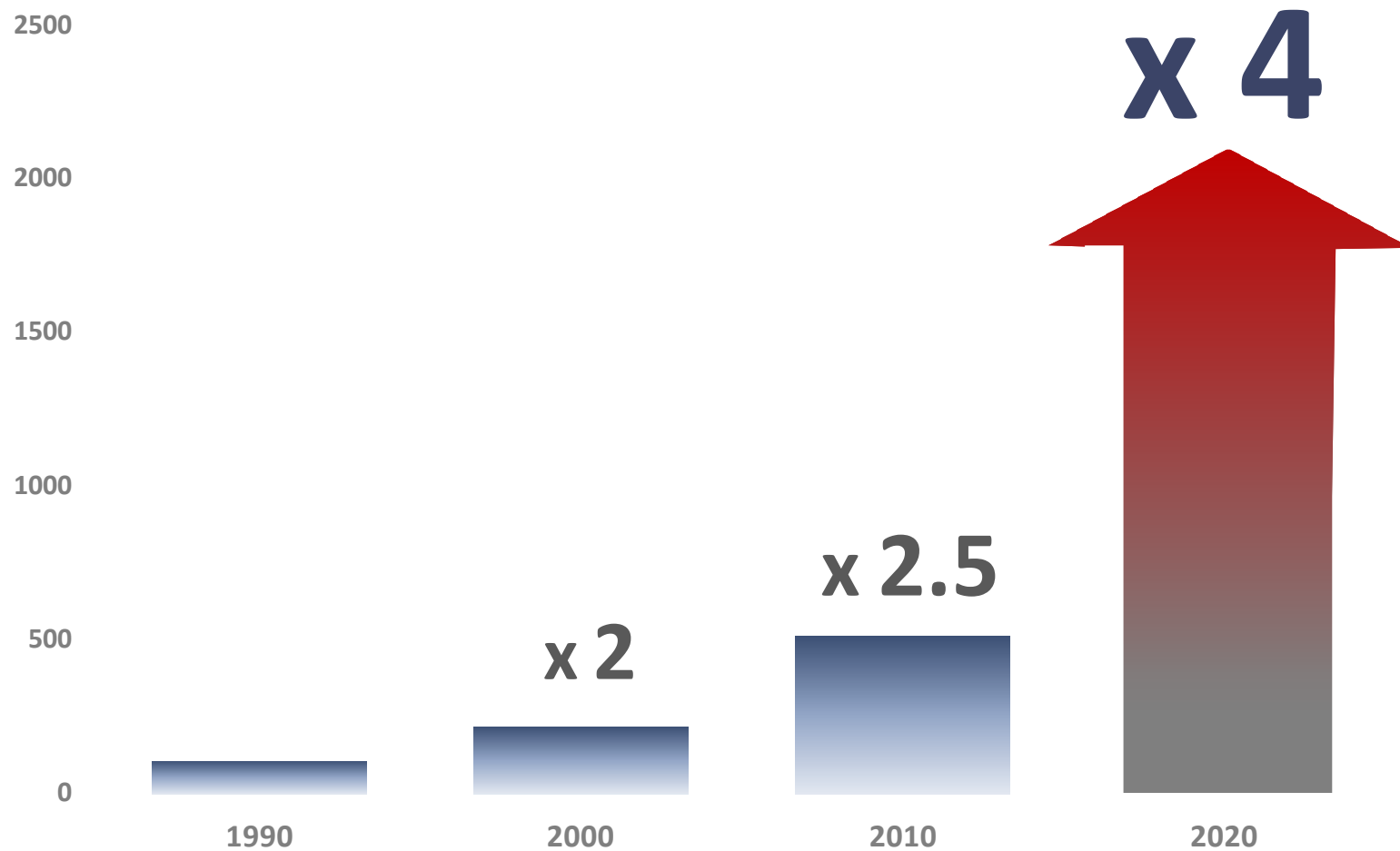
Exponential **growth!**



Automation in the world. Future growth



Exponential **growth**! Relative to km previous decade

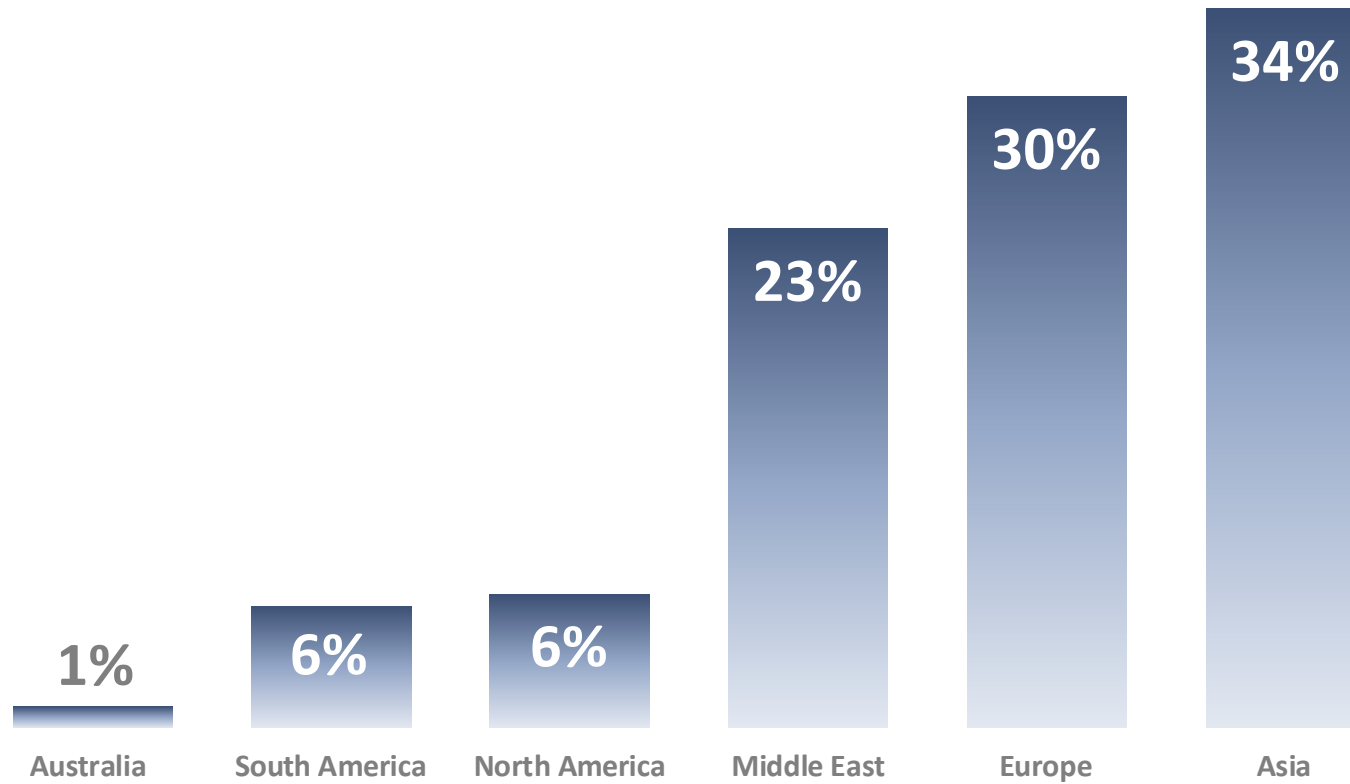


Automation in the world. Future growth



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GoA4 km % per World Region in 2025



CONCLUSIONS



proven



scalable



adaptable

... solution that meets the needs
of diverse mobility scenarios

A **bright** future for metro automation 2025





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Thank you



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Thank You!

